Space Weather Technical Forecast

Issued on Monday 9 December 2024 at 13:01 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of M-class flares with a Slight Chance of isolated X-class Flares, G1/Minor storms and Solar Radiation storms.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate activity with an M1.5 flare at 08/1611 UTC, most likely from AR3912.

There are currently six sunspot regions on the Earth-facing disc. With AR3912 and AR3917 looking the most magnetically complex. Given yesterdays X-class flare from AR3912, further flares must be considered. AR3916, AR3917 and AR3919 are all in close proximity to each other, increasing the likelihood of interaction between them. Other regions appear small and simple at the present time.

Following on from the X2.2 flare on the 08 Dec, analysis suggests that the resulting CME is likely to pass ahead of Earth's orbit, with no or limited impacts at Earth. No other Earth directed CMEs were seen in the last 24 hours.

Solar Wind / Geomagnetic Activity: Solar winds, as recorded at L1 by ACE, showed signs of connecting to a HSS from CH98+. Wind speeds increased from background levels, around 350 km/s, to slightly elevated near 500 km/s, with a brief maximum wind speed of 550km/s around 09/0700 UTC. Density has been below average. The Interplanetary Magnetic Field (Bt) has been largely moderate at around 10nT. The north-south component (Bz) has been mainly weakly negative, -5nT to -7nT with a minima of -9nT just prior to midnight UTC and brief periods of weakly positive between 08/1800 and 08/2200 UTC and again between 09/0100 to 09/0500 UTC. The phi angle was positive (away from the Sun) throughout. Largely Quiet geomagnetic activity with an Active interval between 09/0000-09/0300 UTC.

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 was at background levels. High energy electron flux (greater than 2MeV) observed by GOES16 was at background levels.

The associated 24-hour fluence was below Active, and the 09/0000 UTC observation was 1.34e6 integrated pfu.

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Four-Day Space Weather Forecast Summary

Solar Activity: A Chance of further M-class flares, with a Slight Chance of isolated X-class flares, this risk decreasing slightly after AR3912 rotates off the disc.

Solar Wind / Geomagnetic Activity: No Earth directed CMEs are currently expected. Wind speeds are likely to be slightly elevated for much of this period, mainly due to a HSS connection from CH98/+.

As a result, Quiet to Unsettled geomagnetic conditions are expected with a Chance of Active intervals and a Slight Chance of G1/minor storms if the Bz has extended negative periods.

Energetic Particles / Solar Radiation: There is a Slight Chance of high energy protons reaching the S1/Minor Radiation Storm threshold, mainly due to AR3912.

High energy electron flux is expected to be at background or perhaps moderate levels, but the 24-hour fluence is likely to remain below the Active threshold.

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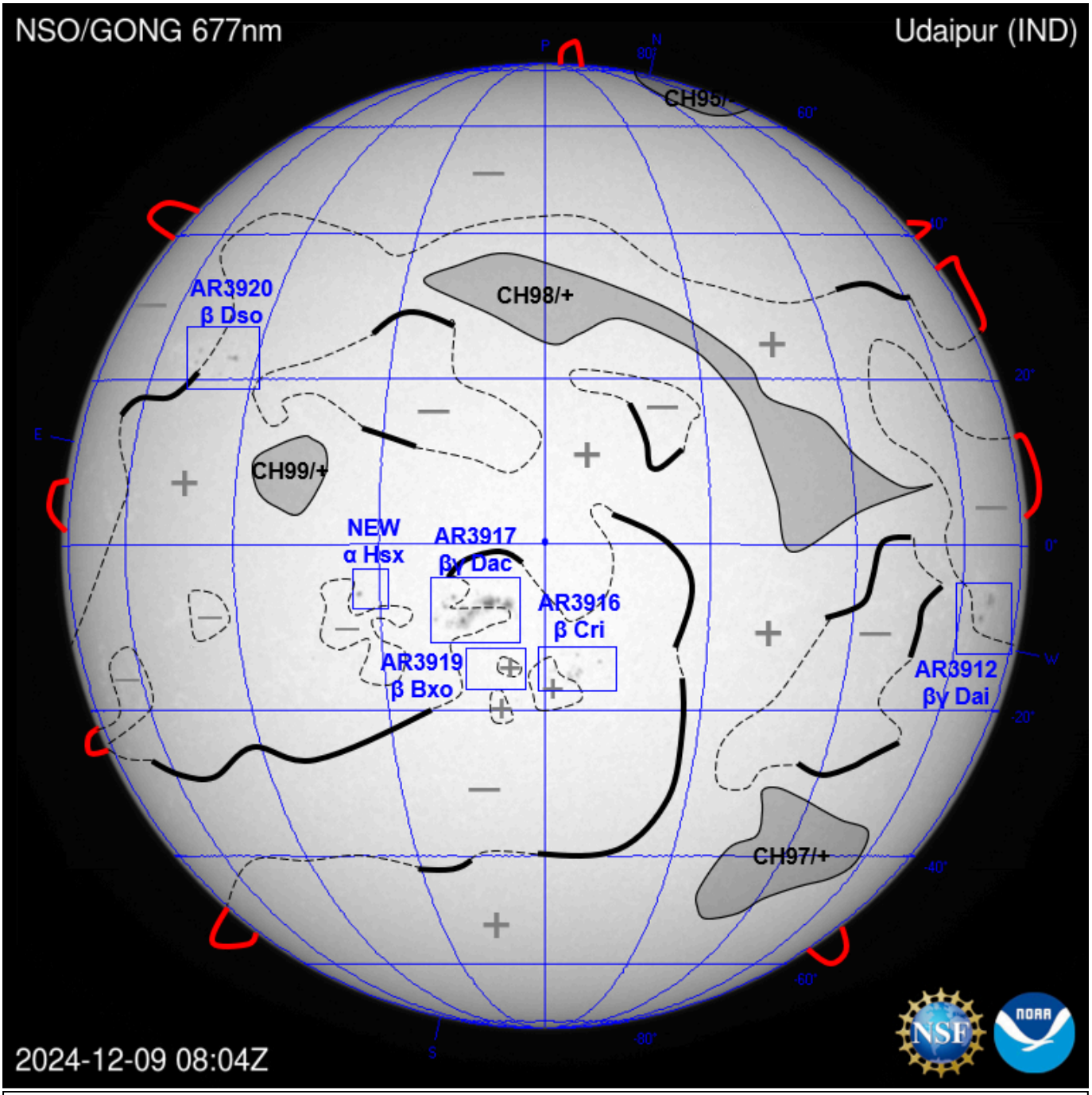
Figure 1: Solar Synoptic Map valid 09/0804 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

Following on from the X2.2 flare at 08/0906 UTC, analysis suggests that the resulting CME is likely to pass ahead of Earth's orbit, with no or limited impacts at Earth.

The current solar wind parameters at L1 suggest a connection to a high speed stream (HSS) from the leading edge of CH98+. While the previous rotation saw little impact from CH98+, in more recent imagery we can see that the leading edge is further south and west, which has resulted in a stronger connection to the coronal hole. Solar winds are currently sitting between 480-500km/s, with MOSWOCs Enlil seeming to provide reasonable guidance with this. Meanwhile the Bz is seeing some fluctuations between negative and positive, and in any prolonged negative spells, there is a Chance we could see periods of Active geomagnetic activity through Day 1 (09 Dec) and into Day 2 (10 Dec) with a Slight Chance of seeing G1/Minor Storm. As the forward edge of CH98+ rotates further round the disc by Day 3 (11 Dec) we are likely to see the connection to the HSS from CH98+ become increasingly weak.

As a result, Quiet to Unsettled geomagnetic conditions are expected with a Chance of Active intervals and a Slight Chance of G1/Minor Storms if the Bz has extended negative periods.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	10	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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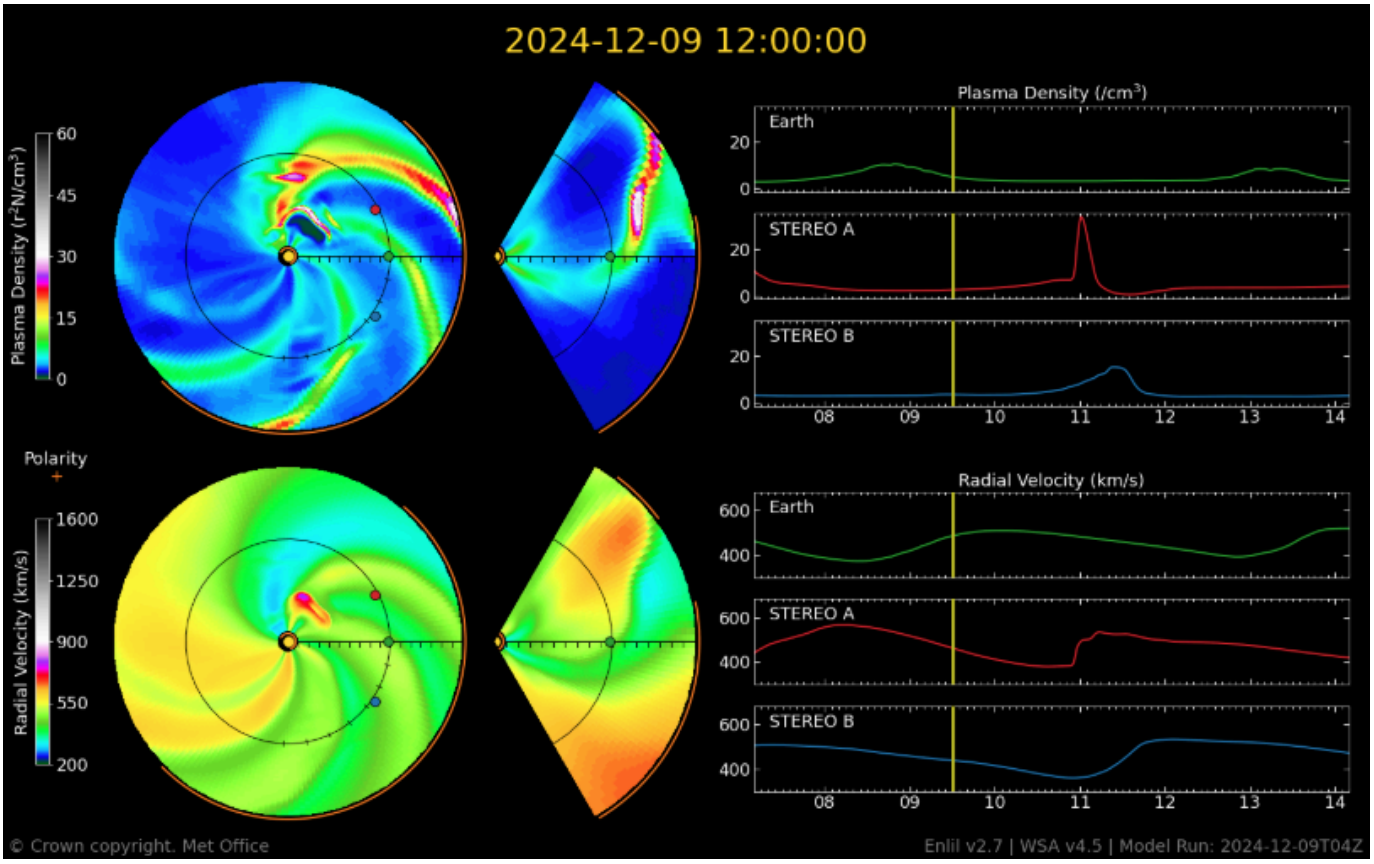
Figure 2: MOSWOC Enlil output offers reasonable guidance to the HSS connection from CH98+.



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Radio Blackouts - X-Ray Flares

There are currently six sunspot regions on the disc, with AR3910 having rotated off the west limb. AR3912 has the potential for a delta spot, although this is uncertain due to the lack of high resolution imagery, particularly as it is starting its approach towards the limb. Given the recent X-flare from this region, it must be considered an ongoing flare risk. AR3917 appears the most magnetically complex region on the disc and did show the potential for a delta spot in the leading group, however in recent imagery appears to be pulling apart. AR3916 appears fairly small and straightforward, with the trailing spots beginning to fade. AR3916, AR3917 and AR3919 are all in close proximity to each other, increasing the likelihood of interaction between them. Other regions appear small and simple at the present time.

In terms of oncoming regions, Ex-AR3903 is due over the southeastern solar horizon inside the next 24 hours - this group produced M-class flares on its last pass. Some looping on the southeast limb suggests the potential for a new region to rotate on in this location, although far side soundings do not detect any significant regions in this location. For departing regions, AR3912, which was responsible for the recent X-flare, will rotate off at the end of Day 2 (10 Dec), with the X-class flare risk reducing during the following 24 hours.

Overall, there is an Chance of isolated M-class flares, with a Slight Chance of an X-flare, this reducing a little later in the period as AR3912 rotates off.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	50	50	50	50
Very Active	R3-R5 (X Class)	No	10	10	10	5

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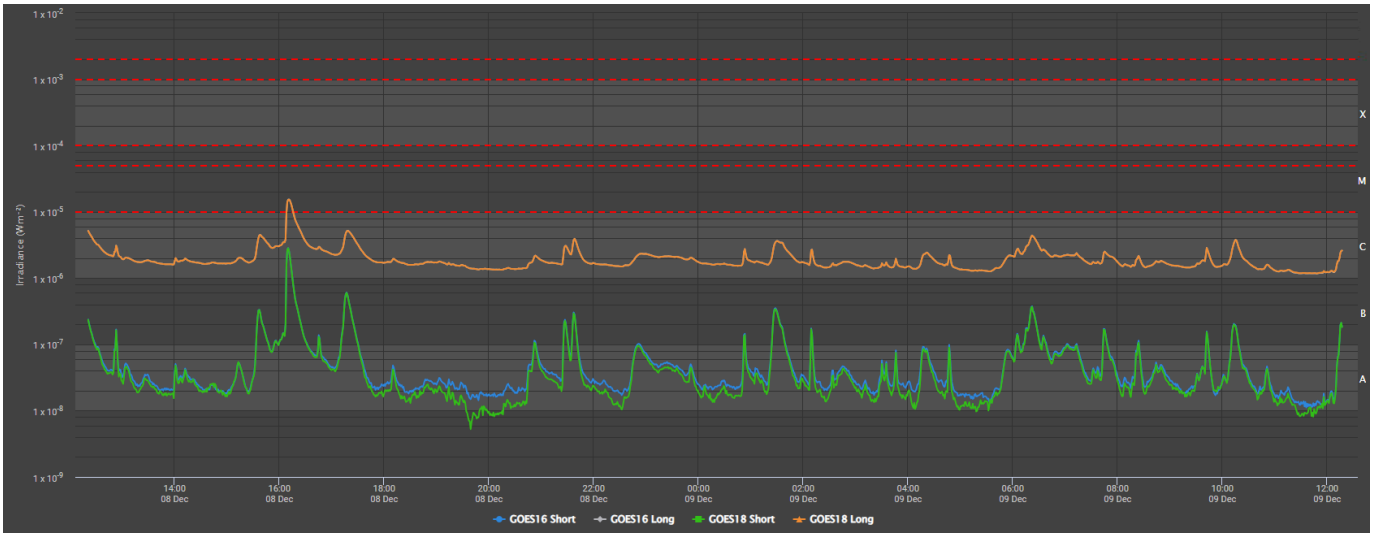
Figure 3: X-ray flares from GOES16&18. Peak flare at 08/1611 UTC of M1.5.



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Solar Radiation Storms (High Energy Protons)

GOES18 proton flux is currently at background levels. The earlier X2.2 flare from AR3912 did not produce a response in the high energy protons, although low energy protons did show a slight rise. Should this region produce another larger flare, then there is a slight chance of a high energy proton response, and this risk remains until AR3912 is well over the limb. Remaining regions on the disc do also contribute a little to this risk, especially as the AR3916/AR3919/AR3917 complex rotates into the western hemisphere.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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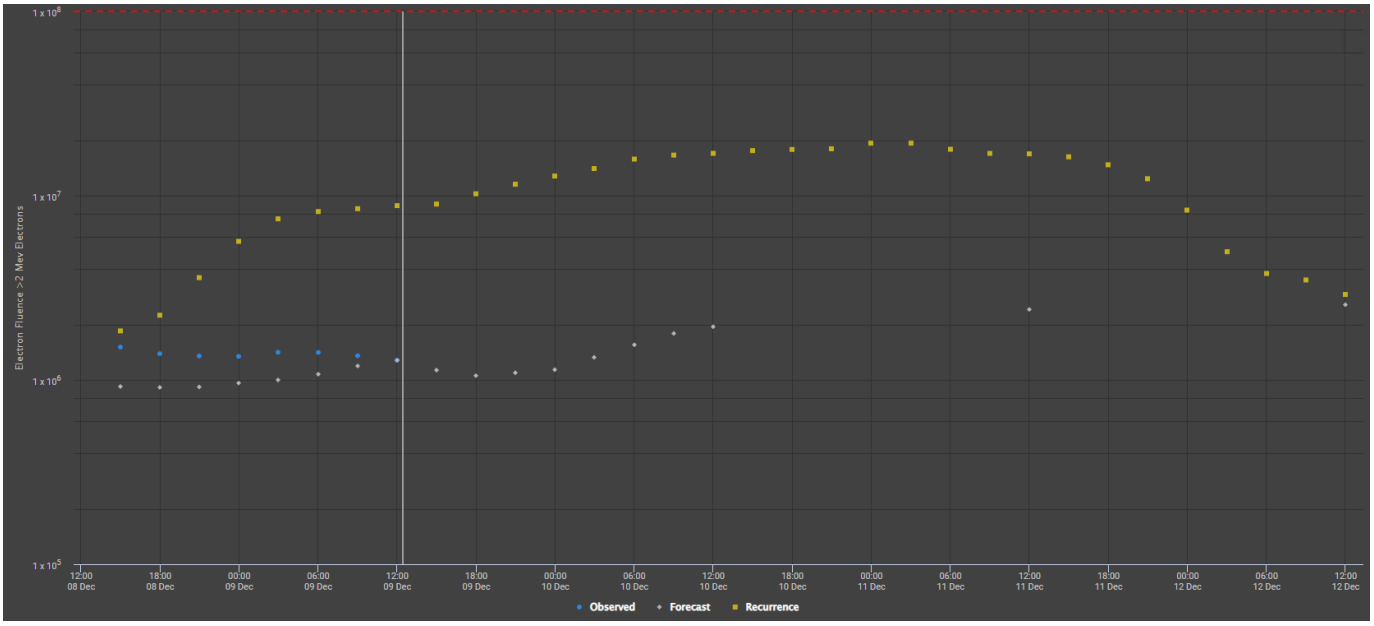
High Energy Electrons (≥ 2MeV)

High energy Electron flux observed by GOES16 has been at background levels. The current high speed stream from the connection to the leading edge of CH98+ has seen wind speeds increase to around 500km/s. As a result, we may see the electron belt charging, and an increase in electron flux as we move through Day 1 (09 Dec) perhaps a Chance of reaching Moderate levels at the diurnal maxima and a Slight Chance of reaching High levels.

The associated 24-hour fluence is expected to remain below the Active threshold, although a slight increase may occur later in the period. MOSWOC REFM is currently showing a flat trend through the next 3 days, which is the most likely outcome.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	1	5
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 4: MOSWOC REFM output showing a largely flat trace in the electron fluence in the coming days.



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